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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample is also included. (AG)

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TECHNICAL REPORT

ON

STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY

FOR

DIE-CASTING-MACHINE OPERATOR (nonfer. metal alloys & prod.) II 6-82.916

B-432 or S-166

U. S. Employment Service in
Cooperation with
California State Employment Service

TM 001 598

U. S. DEPARTMENT OF LABOR
Bureau of Employment Security
Washington 25, D. C.

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STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY FOR DIE-CASTING-MACHINE OPERATOR II 6-82.916

B-432 or S-166

Summary

The General Aptitude Test Battery, B-1002A, was administered to a sample of 50 men employed as Die-Casting-Machine Operator II 6-82.916 at 12 firms in Southern California. The criterion consisted of combined supervisory ratings based on a descriptive rating scale. On the basis of mean scores, standard deviations, correlations with the criterion, job analysis data, and their combined selective efficiency, Aptitudes S-Spatial Aptitude, P-Form Perception, and F-Finger Dexterity were selected for inclusion in the test norms.

GATB Norms for Die-Casting-Machine Operator II 6-82.916 - B-432 or S-166

Table I shows, for B-1001 and B-1002, the minimum acceptable score for each aptitude included in the test norms for Die-Casting-Machine Operator II 6-82.916.

Minimum Acceptable Scores on B-1001 and B-1002 for B-432 or S-166

B-1001			B-1002		
Aptitude	Tests	Minimum Acceptable Aptitude Score	Aptitude	Tests	Minimum Acceptable Aptitude Score
S	CB-1-F CB-1-H	85	S	Part 3	80
P	CB-1-A CB-1-L	75	P	Part 5 Part 7	75
F	CB-1-O CB-1-P	80	F	Part 11 Part 12	75

Effectiveness of Norms

The data in Table V indicate that 14 of the 17 poor workers, or 82 percent of them, did not achieve the minimum scores established as cutting scores on the recommended test norms. This shows that 82 percent of the poor workers would not have been hired if the recommended test norms had been used in the selection process. Moreover, 26 of the 29 workers who made qualifying test scores, or 90 percent, were good workers.

TECHNICAL REPORT

I. Problem

This study was conducted to determine the best combination of aptitudes and minimum scores to be used as norms on the General Aptitude Test Battery for the occupation of Die-Casting-Machine Operator II 6-82.916.

II. Sample

During the period April 14 to April 29, 1959, the GATB, B-1002A was administered to a sample of 61 male workers employed as Die-Casting-Machine Operator II 6-82.96 at twelve firms in Southern California. Of the 61 workers tested, 11 were eliminated from the sample: five because they were performing work that was not comparable to the other workers in the sample, three because they were unable to understand instructions for the tests, one because three fingers had been amputated from his left hand, one because he was having difficulty because of broken glasses, and one because he lacked the necessary experience. Therefore, the final sample consisted of 50 men. The names of the companies and the number of workers included in the final sample for each firm are shown below.

Company	Number
Los Angeles Die Casting	6
Pabcast Die Casting	2
Rangers Die Casting	2
Pioneer Die Casting	3
Ambrit Industries Incorporated	1
Alloy Die Casting Company	6
Anderson Die Casting	4
Hyatt Die Casting	3
Union Die Cast	6
Withrow Die Casting	2
Harvill Manufacturing Company	12
Die Cast Products Incorporated	3
	50

Tests have not been used for selection of workers for this occupation in any of the twelve plants. Entrance requirements vary in the plants. Some prefer to hire workers with one to two years of experience, others prefer to hire trainees to train in company methods. Trainees are screened on their interests and background. Applicants are required to complete an application form and have an oral interview. There are no age or educational requirements but applicants must be able to speak, read, and write English.

There are no formal training programs, and on-the-job training is used with the trainee assigned as an operator or helper. There is no specific training time or established rate of progress. The average length of time for training is 3 to 6 months. All workers in the sample were considered experienced workers.

Table II shows the means, standard deviations, ranges, and Pearson product-moment correlations with the criterion for age, education, and experience.

TABLE II

Means (M), Standard Deviations (σ), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education, and Experience

Die-Casting-Machine Operator II 6-82.916

N = 50

	M	σ	Range	r
Age (years)	35.1	8.7	22-59	-.033
Education (years)	9.8	2.2	5-14	.098
Experience (months)	101.5	57.4	6-228	.075

There are no significant correlations with the criterion for age, education, or experience. Each worker included in the sample had at least 6 years of education except one worker who had 5 years. Although the test scores for the worker with 5 years of education were lower than scores for the rest of the sample, he was retained in the sample because his inclusion in the sample did increase the size of sample and had no effect on the outcome of the study.

III. Job Description

Job Title: Die-Casting-Machine Operator II 6-82.916

Job Summary: Mass-produces parts and castings from such metals as brass, aluminum, and magnesium, using semi-automatic die-casting machine. Alines and adjusts die in machine framework, regulates water supply valves, and heats die to proper temperature with gas torch. Lubricates die to prevent sticking; closes and locks die sections. Determines operating speed of machine based on atmospheric conditions, complexity and temperature of die, and characteristics and temperature of alloy being cast. Ladles molten or semi-molten metal from furnace pot, visually determining that ladle contains necessary amount to produce complete casting. Manipulates controls to operate water-cooled ram or plunger which forces metal into cavities of die and maintains pressure until metal solidifies. Removes castings when machine automatically opens, using asbestos gloves or tongs, or by catching them in asbestos-covered machine.

Work Performed:

Pre-operation Procedure: Takes over preset and proof run casting machine from set-up man. Reviews die history card with leadman and receives instructions pertaining to type of metal, operating temperature, frequency of lubricating and cleaning die surfaces, and amount of molten metal to be poured with ladle assigned to job by set-up man. Visually inspects safety lamp filament and, if not intact, notifies leadman for replacement. Visually inspects ladle and, if wet, wipes with rag or glove.

Loading Machine: Takes position between furnace and machine and picks up ladle with right hand. Dips ladle gradually into crucible of furnace to prevent cold ladle from causing the hot molten metal to erupt and spray all over the furnace area. Removes filled ladle from crucible after the molten metal stops bubbling, visually determining that the ladle contains necessary quantity to produce a complete casting. Turns back, facing the machine, and pours molten metal into well of injection cylinder sleeve making certain not to pour an excessive amount of metal which would cause a blow back. Turns back to furnace and places ladle along side crucible on furnace shoulder.

Operating Machine: Walks to electric switch box, separated from machine for safety factor, and depresses button to start machine casting cycle. Walks to position in front of dies and waits for safety light to go out indicating completion of casting cycle.

Unloading Machine: Reaches overhead and pulls back on lever with left hand to partially disengage casting from rear die. Reaches in between open die halves with asbestos gloved hand, pliers, or tongs to grab hold of and remove casting. Visually inspects casting to detect malformation caused by insufficient amount of metal, improper lubrication, dirty die surfaces, or by machine malfunction. Turns to rear or to one side to place casting on bench or into bin; or throws rejected casting into proper scrap barrel identified by type of metal.

Preparing for next operation: Picks up double hose line with right hand from hook on side of machine. Directs nozzle at die surfaces, depressing trigger to release combined air blast and lubricating agent to clean and lubricate die surfaces. Walks back to furnace and picks up ladle to repeat loading and unloading operations, coordinating movements with casting cycle of machine.

Recurrent operations: Applies lubricating grease with rag swab in injection cylinder port, on exposed parts of injection cylinder and plunger to prevent galling of cylinder tip and to ensure smoother action, at intervals according to type of metal being cast. Visually inspects castings during operations for indications of sticking and applies lubricating oil or rubs paraffin stick on portion of die surface causing casting to stick when necessary. Lubricates die ejector pins by hand with piston grease three times per shift. Applies piston grease on all dowel pins on the die every hour. Skims surface of molten metal in crucible once per hour with ladle to remove dross and pours skimmings in slag pan located beside furnace. Replenishes crucible with molten metal as required, assisting utility man in lifting and pouring by hand into crucible from large container rolled to furnace. Dips ladle into molten metal at end of shift to remove any cooled residue from previous operations. Wipes clean with an old glove or rag. Walks along line of machines to end of bay carrying ladle to ladle-wash stand. Dips ladle in bucket of cold water on stand to cool. Stirs ladle-wash in bucket with a brush so that it is well mixed. Brushes ladle with wash giving it an even coat to prevent metal from sticking during subsequent operations. Returns to machine and sets ladle on top of furnace exhaust to dry for next operator. Empties slag pan into proper scrap barrel and cleans around work area.

IV. Experimental Battery

All the tests of the GATB, B-1002A, were administered to the sample group.

V. Criterion

The criterion consisted of supervisory ratings based on the Descriptive Rating Scale developed by the Bureau of Employment Security, Form SP-21. First line supervisors prepared ratings and reratings for each worker with a time interval of two weeks to eighteen days between the first and second ratings. The rating scale consisted of 9 items covering different aspects of job performance with five alternatives for each item. Weights of one through five indicating the degree of job performance attained were assigned to each alternative. A correlation coefficient of .94 was obtained between the two sets of ratings. The final criterion consisted of the combined rating scale scores. The possible range of scores was 18 through 90. The actual range was 39 through 90 with a mean score of 65.0 and a standard deviation of 13.9.

VI. Qualitative and Quantitative Analyses

A. Qualitative Analysis:

The job analysis indicated that the following aptitudes measured by the GATB appear to be important for this occupation.

Intelligence (G) - required to learn physical properties of nonferrous metals and alloys to distinguish one from another and to understand their varying reactions under heat and pressure; to exercise independent judgment in retaining or rejecting castings and to understand and carry out instructions pertaining to die casting cycle.

Form Perception (P) - required in visually inspecting safety lamp filament to make certain that it is intact, in visually determining proper amount of molten metal in ladle to be poured into well of injection cylinder sleeve, and in inspecting die castings for malformations.

Motor Coordination (K) and Manual Dexterity (M) - required in dipping ladle into crucible, removing ladle filled with molten metal and pouring molten metal into well of injection cylinder sleeve; in manipulating levers of machine and removing castings, using pliers and tongs; in lubricating and cleaning machines and dies.

On the basis of job analysis data, the following aptitudes are considered obviously unimportant for performing the duties of this job and are considered "irrelevant" aptitudes: Verbal Aptitude, Numerical Aptitude, and Clerical Perception.

B. Quantitative Analysis:

Table III shows the means, standard deviations, and Pearson product-moment correlations with the criterion for the aptitudes of the GATB. The means and standard deviations of the aptitudes are comparable to general working population norms with a mean of 100 and a standard deviation of 20.

TABLE III

Means (M), Standard Deviations (σ), and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB

Die-Casting-Machine Operator II 6-82.916

N = 50

Aptitudes	M	σ	r
G-Intelligence	84.9	13.8	.320*
V-Verbal Aptitude	84.6	12.5	.145
N-Numerical Aptitude	83.0	16.6	.285*
S-Spatial Aptitude	86.0	16.9	.401**
P-Form Perception	85.4	15.7	.356*
Q-Clerical Perception	86.6	10.3	.241
K-Motor Coordination	89.1	15.1	.314*
F-Finger Dexterity	95.3	17.3	.341*
M-Manual Dexterity	98.0	15.3	.268

**Significant at the .01 level
*Significant at the .05 level

Aptitudes K, F, and M have the highest mean scores and Aptitudes G, V, and Q have relatively low standard deviations.

For a sample of 50 cases, correlations of .361 and .279 are significant at the .01 level and the .05 level of confidence, respectively. Aptitude S correlates significantly with the criterion at the .01 level. Aptitudes G, N, P, K, and F correlate significantly with the criterion at the .05 level.

C. Selection of Test Norms:

TABLE IV

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	M
Job Analysis Data									
Important	X				X		X		X
Irrelevant		X	X			X			
Relatively High Mean							X	X	X
Relatively Low Sigma	X								
Significant Correlation with Criterion	X			X	X		X	X	
Aptitudes to be Considered for Trial Norms	G			S	P		K	F	M

Trial norms consisting of various combinations of Aptitudes G, S, P, K, F, and M with appropriate cutting scores were evaluated against the criterion by means of the tetrachoric correlation technique.

A comparison of the results showed that two sets of B-1002 norms with identical four-way tables had better selective efficiency than any other combination of aptitudes and cutting scores: (1) S-80, P-75, and F-70 and (2) S-80, P-75, and F-75. In such instances, one basis for selecting final norms is to find which set of norms is more suitable in terms of qualifying for incorporation into the OAP structure. Since neither of the two sets of norms qualified the study to be tried for integration into the existing OAP structure, the norms with cutting scores closest to one standard deviation unit below the aptitude means obtained for the sample were selected as the final norms. Thus, the final B-1002 norms consist of S-80, P-75, and F-75.

VII. Validity of Norms

For the purpose of computing the tetrachoric correlation coefficient between the test norms and the criterion and applying the Chi Square test, the criterion was dichotomized by placing as close as possible to one-third of the sample in the low criterion group. A combined rating scale score of 57 was used as the criterion critical score. This resulted in 17 of the 50 workers or 34 percent of the sample being placed in the low criterion group.

Table V shows the relationship between test norms consisting of Aptitudes S, P, and F with critical scores of 80, 75, and 75 respectively, and the dichotomized criterion for Die-Casting-Machine Operator II 6-82.916. Workers in the high criterion group have been designated as "good workers" and those in the low criterion group as "poor workers."

TABLE V

Validity of Test Norms, S-80, P-75, and F-75

N = 50

	Non-Qualifying Test Scores	Qualifying Test Scores	Total
Good Workers	7	26	33
Poor Workers	14	3	17
Total	21	29	50

$r_{tet} = .82$ $\qquad$ $\chi^2 = 14.799$

$\sigma_{r_{tet}} = .23$ $\qquad$ $P/2 < .0005$

The data in the above table indicate a significant relationship between the test norms and the criterion for the sample.

VIII. Conclusions

On the basis of the results of this study, Aptitudes S, P, and F with minimum scores of 80, 75, and 75 respectively, have been established as B-1002 norms for the occupation of Die-Casting-Machine Operator II 6-82.916. The equivalent B-1001 norms consist of S-85, P-75, and F-80.

IX. Determination of Occupational Aptitude Pattern

The specific norms established for this study did not meet the requirements for allocation to any of the existing 23 occupational aptitude patterns. The data for this sample will be considered for future groupings of occupations in the development of new occupational aptitude patterns.